1996 Automotive Technology Development Customers' Coordination Meeting

Investigation and Demonstration of a Rich Combustor Cold Start Device for Alcohol Fueled Engines

Principal Investigators

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Objective

- Design and fabricate a rich combustor device intended to facilitate cold starting of alcohol-fueled spark ignition engines.
- Demonstrate cold starting and drive-away at temperatures as low as -30^{o}C.
- Integrate the rich combustor with a vehicle for automatic operation.
- Research is in support of Alternative Fuels Utilization Engine Optimization.

Approach

- The University of Tennessee has previously conducted proof-of-concept tests that have shown a methanol-fueled spark ignition engine can be started with gases produced by a rich combustor device fueled with methanol.
- The gases generated by the rich combustor device contain the noncondensable flammable gases hydrogen and carbon monoxide that serve to start the engine at temperatures as low as -30^{o}C.

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Accomplishments

- A model has been developed to simulate constant pressure adiabatic combustion, including dissociation of the products.
  - Calculations have been made using the model to simulate combustion of rich mixtures of methanol and air at -30^{o}C to determine the concentration of hydrogen and carbon monoxide in the product gas under the equilibrium assumption.
  - Typical results are shown in Figure 1.
- An engine model has also been developed to simulate the use of the combustor products for fueling the engine
  - The engine model is used to simulate cold start and driveaway to determine the fuel requirements for operation of the rich combustor.
- A prototype rich combustor has been fabricated and installed on the test engine located inside a refrigerated enclosure and coupled to an engine dynamometer which allows testing of the entire system, minimizing the task of vehicle integration.
  - The prototype is installed between the existing throttle body and the intake manifold on the engine, and divides the air flowing through the throttle body into two (physically three) streams.
  - One stream flows through the combustion chamber where fuel is added and ignited. The fuel droplets burn in a rich diffusion flame to produce the desired products which will be used to fuel the engine. This stream can be throttled to reduce the flow through it as the engine warms up.
  - The remaining air flow is directed around the combustion chamber unaffected except for heat transfer from the combustion chamber and rejoins the combustor products prior to entering the intake manifold.
  - Figure 2 shows the first generation rich combustor design.
- The test engine has been started at room temperature using the rich combustor

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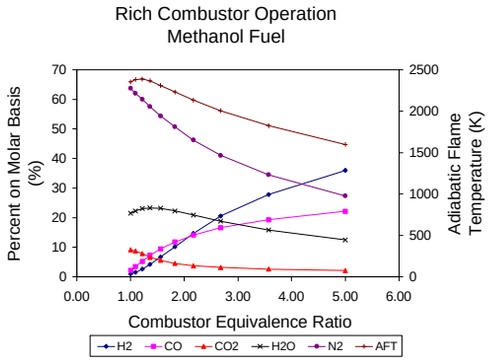

Figure 1 Product Composition vs. A/F

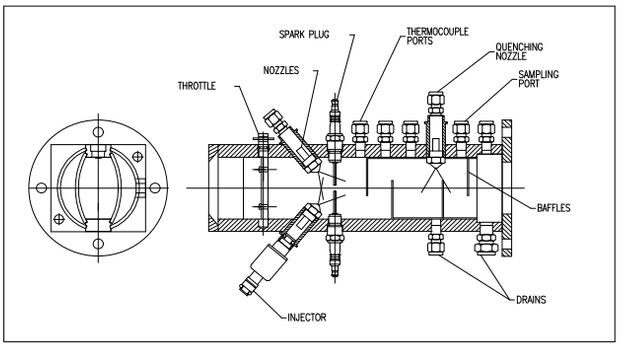

Figure 2 First Generation Combustor Design

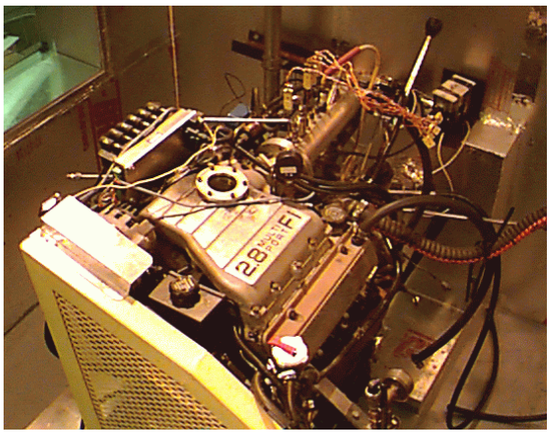

Figure 3 Engine in test cell

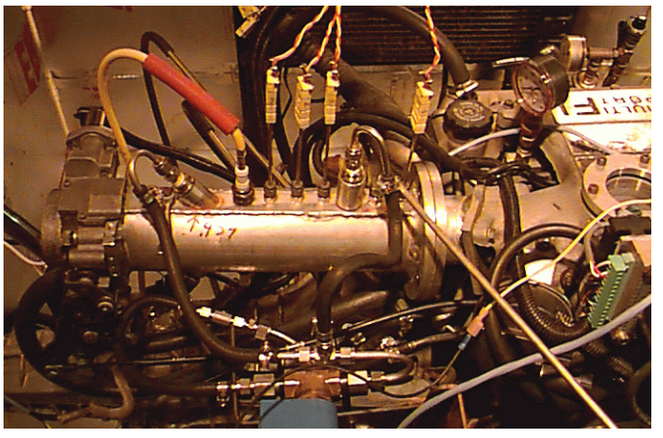

Figure 4 Combustor installed on engine

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Future Direction

- The rich combustor has been redesigned based on the results of testing the first generation combustor design. The second generation design configuration is shown below.
- The second generation design is currently being fabricated and will be installed on the engine in the test cell.
- Once the operating parameters are determined for the range of temperatures considered, emission and fuel economy tests will be performed.
- The second generation rich combustor will be installed on the test vehicle and operational tests perfomed.

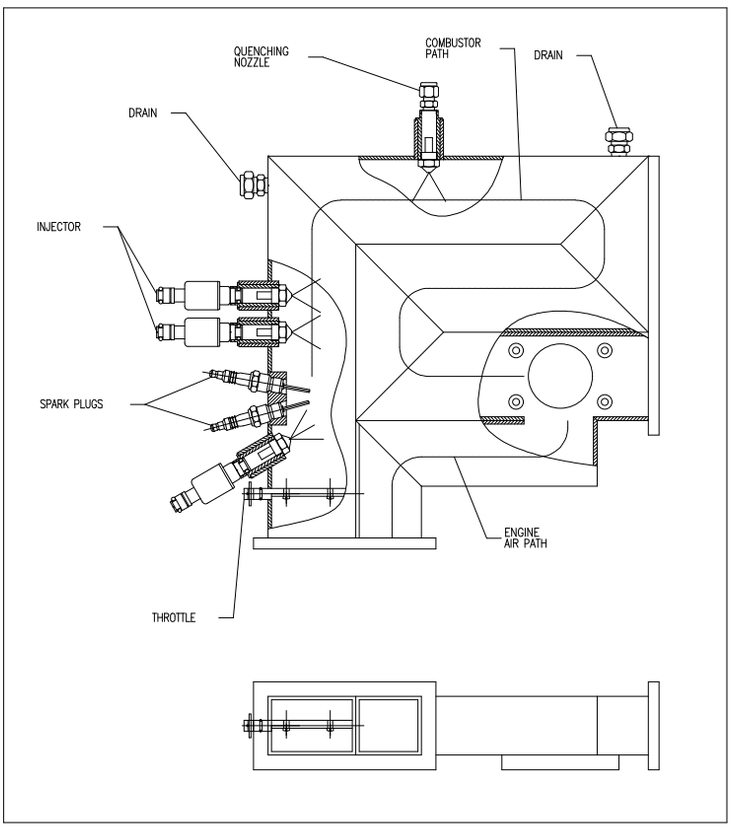

Figure 5 Second generation combustor design